

substantially insert gas, such as argon, nitrogen and/or helium, and about 5% by volume of a reducing gas, such as hydrogen and/or carbon monoxide for flash welding and induction butt welding.

5 Experiments have shown that forge welding techniques are capable to generate high quality metallurgical bonds between tubular ends, in particular if the pipe ends are flushed with a reducing flush gas mixture during the heating and/or welding operation, but that the red-hot
10 pipe ends are generally deformed such that upsets are formed in the region of the welding zone.

15 For many applications it is required to remove upsets after the welding operation, which then involves a grinding or machining operation which is difficult and expensive to accomplish at many sites where pipe ends are welded together, such as on oil rigs, pipe-laying barges and many offshore and onshore sites where underground or above ground pipelines are to be installed.

20 It is an object of the present invention to provide a method for forge welding of tubulars wherein the generation of upsets in the welding zone is minimized.

Summary of the Invention

25 The method according to the inventions comprises shaping the tubular ends that are to be welded together into a sloping configuration such that when the tubular ends are heated during the forge welding process the heated tubular ends deform as a result of thermal expansion into a substantially longitudinally oriented cylindrical shape.

30 In addition the portion of each pipe that is to be forged may be reduced in cross section such that deformation during forging returns it to a dimension substantially the same as its original thickness.

C L A I M S

1. A method for interconnecting tubulars by forge welding, the method comprising shaping the tubular ends that are to be welded together into a sloping configuration; characterized in that the sloping configuration is such that when the tubular ends are heated during the forge welding process the heated tubular ends deform as a result of thermal expansion into a substantially longitudinally oriented cylindrical shape.
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10. The method of claim 1, wherein the sloping angle of the inner and outer walls of the tubular ends is selected such that the ratio between the average diameter $D(t)$ of the tip of the tubular end and the average diameter $D(b)$ of the base of the tubular end is related to an estimated temperature difference between said tip and base of the tubular end during the forge welding process and a thermal expansion co-efficient of the steel grade or grades of the tubular end.
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15. The method of claim 2, wherein said ratio $D(t)/D(b)$ is between 0.8 and 0.99.
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20. The method of claim 1, wherein the end face of one of the tubular ends that are to be welded together has a substantially convex shape and the end face of the other tubular has a substantially concave shape.
25. The method of any preceding claim, wherein the tubular ends are machined to a reduced wall thickness in the welding zone.
25. The method of claim 4, wherein tubulars comprise a low grade steel base pipe and a higher grade steel

cladding on the inner and/or outer surface of the base pipe and the end faces are shaped such that when the tubular ends are pressed together the end faces of the cladding(s) touch each other before the end faces of the
5 base pipe ends touch each other.

7. The method of claim 6, wherein the tubular ends are wedge shaped and the tips of the wedges are formed by the claddings.

10 8. The method of any one of claims 1-5, wherein only the adjacent end portions of adjacent low grade steel base pipes are covered with clad metal to allow further machining of said end portions without exposing the base pipes.

15 9. The method of claim 6, wherein during at least part of the forge welding operation a flushing gas is flushed around the welding zone and at least part of the flushing gas is injected into the welding zone from the unclad side of the tubular, such that the injected flushing gas can continue to reach the ends of the still
20 spaced base pipes after the claddings have touched each other.

10. The method of claim 9, wherein the flushing gas is a reducing flushing gas.

15 11. The method of claim 10, wherein the flushing gas is a non-explosive mixture of a substantially inert gas and a reducing gas.

25 12. The method of claim 11, wherein the substantially inert gas comprises helium, argon, nitrogen, and/or carbon dioxide and the reducing gas comprises hydrogen and/or carbon monoxide.
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13. The method of claim 12, wherein the non-explosive flushing gas mixture comprises more than 90% by volume

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of a substantially inert gas and at least 2% by volume of hydrogen.

14. The method of any preceding claim, wherein the tubulars are oilfield and/or well tubulars.